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COMMUNITY PRODUCTION OF EGYPTIAN COTTON IN THE UNITED STATES.

By C. S. Scofield, T. H. Kearney, C. J, Brand, O. F. Cook, and W. T. Swingle
(constituting the Committee on Southwestern Cotton Culture).

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INTRODUCTION.

The purposes of this bulletin are to tell how Egyptian-cotton production became established in the Southwest as a result of community action, to describe the present status of the industry, and to give the reasons for encouraging the growing of this type of cotton in the United States. Attention is also directed to the conditions which appear to be indispensable to its successful commercial production in this country. It is believed that Egyptian cotton can not be profitably grown except under irrigation and in the absence of the boll weevil. This would exclude it from consideration in any portion of what is generally known as the cotton belt.

The principle of community action in cotton production implies the growing of only one variety, the variety selected being that which is best adapted to the physical and economic conditions of the locality.[1] In no other way is it possible to maintain a supply of pure seed and to market year after year a uniform high-grade product. These objects can be attained only by effective cooperation on the part of the growers. The lesson taught by this successful application of the community principle should make the present publication interesting to many who are engaged in growing, selling, or manufacturing cotton, even though they may not be concerned with the special subject of Egyptian-cotton production.

SOURCES OF LONG-STAPLE COTTON.

The three most important types of long-staple cotton are (1) Sea Island cotton, (2) long-staple Upland cotton, and (3) Egyptian cotton.

Sea Island cotton is grown on the islands along the coasts of South Carolina and Georgia and in certain counties on the mainland of Georgia and Florida, as well as to a limited extent in portions of the West Indies. During recent years the crop of Sea Island cotton in the United States has amounted to from 60,000 to 120,000 bales[2] per annum. The staple of Sea Island cotton ranges from $1\frac{1}{2}$ to $1\frac{5}{8}$ inches in the Georgia and Florida product to 2 inches in the best qualities grown on the Sea Islands proper.[3]

Long-staple Upland cotton has been for many years produced chiefly in the so-called Delta region of western Mississippi. In recent years the production of this type of cotton has been extended into eastern Arkansas and northeastern Texas, and a small quantity has also been grown in the Carolinas. Still more recently the growing of long-staple Upland cotton has been established on irrigated lands in the Imperial Valley of California, the industry in that locality being based on the Durango variety. The quantity of long-staple Upland cotton produced annually in the United States is not definitely known. A recent publication of the Bureau of Crop Estimates[4] places the total at slightly more than 400,000 bales, although

[1] Cook, O. F. Cotton improvement on a community basis. *In* U. S. Dept. Agr. Yearbook, 1911, p. 397–410, 1912. See also Swingle, W. T., The fundamentals of crop improvement, in U. S. Dept. Agr., Bur. Plant Indus. Cir. 116, pp. 3–10, 1913.

[2] The Sea Island cotton bale averages in weight slightly less than 400 pounds. For further information, see Meadows, W. R., Economic conditions in the Sea Island cotton industry, U. S. Dept. Agr. Bul. 146, 18 p., 1914.

[3] A small proportion of the island product reaches a length of $2\frac{1}{4}$ and rarely even $2\frac{1}{2}$ inches.

[4] The Agricultural Outlook. U. S. Dept. Agr., Farmers' Bull. 651, p. 13, 1915. See also Taylor, Fred, and Sherman, W. A., Spinning tests of Upland long-staple cottons, U. S. Dept. Agr. Bul. 121, 20 p., 1914.

it is explained that this quantity probably includes chiefly cotton $1\frac{3}{16}$ inches and more in length. If the designation "long staple" be taken to comprise all Upland cotton having a staple of more than $1\frac{1}{16}$ inches in length, it is probable that the American production exceeds 1,000,000 bales annually. While a few varieties of long-staple Upland cotton sometimes produce fiber having a staple of $1\frac{1}{2}$ inches or longer, the bulk of the crop is less than $1\frac{3}{8}$ inches in length.

Egyptian cotton until very recently has been produced commercially only in the delta and lower valley of the Nile River, in Egypt. In recent years the Egyptian crop has amounted annually to the equivalent of about one and a half million 500-pound bales.

CHARACTER AND SUPPLY OF EGYPTIAN COTTON.

Egyptian cotton is a distinct type, both botanically and commercially, comprising several varieties and having a total range of staple of from $1\frac{1}{4}$ to $1\frac{5}{8}$ inches. The history of cotton growing in Egypt since the present definite type was developed in that country about 65 years ago has been marked by the successive appearance of numerous varieties. Each of these, after having been extensively grown for a number of years, has shown marked deterioration due to intercrossing.

The most striking characteristics of the Egyptian fiber are its length of staple combined with great strength and fineness. The older varieties, Ashmuni and Mit Afifi, are characterized by a brown or, more properly, pinkish buff color of the fiber, but the Sakellaridis variety, which is now highest in favor among spinners, is nearly white, or almost as light in color as Sea Island cotton.

Egyptian cotton is used especially in the manufacture of goods in which strength or fineness or a combination of both qualities is desired. Some of the principal articles manufactured from this cotton are sewing thread, hosiery, automobile-tire fabrics, and fine and fancy dress goods. Until a few years ago mercerized fabrics were made only from Egyptian cotton, but the process of mercerization has now been developed so that other cottons can be successfully treated. "Balbriggan" underwear was formerly manufactured exclusively from the brown Egyptian cottons, but dyed white cottons are now also employed for this purpose.

The cotton crop of Egypt is grown entirely on irrigated land in a climate which is practically rainless throughout the period of development of the cotton plants. The absence of rain during the picking season favors the production of clean cotton. The average yield for the entire cotton acreage in Egypt is about 435 pounds of lint per acre. The recent annual production of cotton in Egypt is shown in Table I.

TABLE I.—*Total production of cotton in Egypt, exclusive of the Sudan, for the past five years, in kantars and in the equivalent of 500-pound bales.*[1]

Year.	Kantars.	500-pound bales.
1909	5,001,000	990,200
1910	7,505,000	1,486,000
1911	7,386,000	1,462,430
1912	7,499,000	1,485,000
1913	7,684,000	1,521,430

[1] The kantar equals 99.049 pounds. The Egyptian bale contains about 750 pounds, but for readier comparison the conversion is made in the table into the equivalent of the American bale of 500 pounds. The figures in the table are taken from those published by the Egyptian Ministry of Agriculture. (Mo. Return [Min. Agr. Egypt], year 3, no. 2, 16 p., Oct. 31, 1914.)

About 60 per cent of the entire Egyptian crop is exported to Great Britain and a smaller proportion to the United States (10 per cent in 1910 and 1911 and 13 per cent in 1912). The remainder is exported mainly to the countries of continental Europe.

AMERICAN CONSUMPTION OF EGYPTIAN COTTON.

Notwithstanding the fact that nearly two-thirds of the American cotton crop is exported for manufacture in foreign countries, a large and steadily increasing quantity of raw cotton is imported for manufacture in the United States. By far the larger part of this imported cotton is obtained from Egypt. Table II shows the imports of Egyptian cotton for the past 10 years. These figures are taken from those published by the Bureau of the Census.[1] They show that the quantity imported varies somewhat from year to year, but the tendency is toward an increase in the importations.[2]

TABLE II.—*Imports of Egyptian cotton for the crop-distribution years from 1905 to 1914, inclusive, stated as 500-pound bales.*

Year.	Quantity imported, in 500-pound bales.	Year.	Quantity imported, in 500-pound bales.
1905	108,283	1910	102,217
1906	103,669	1911	183,786
1907	169,731	1912	175,835
1908	120,187	1913	191,075
1909	129,985	1914	137,355

The shorter kinds of Egyptian cotton ($1\frac{1}{4}$ to $1\frac{3}{8}$ inch staple), the so-called brown Egyptian and Upper Egypt cottons, produced by the Mit Afifi and Ashmuni varieties, respectively, are used by

[1] Supply and distribution of cotton. Bureau of the Census [U. S.] Bul. 117 [1912]/13 40 p., 1913; Bul. 128 [1913]/14, 30 p., 1914. These bulletins have been published annually since 1905. The figures cover the crop-distribution year from September 1 to August 31, and hence refer to the crop produced in the previous calendar year.

[2] According to figures published by the Bureau of the Census, the total imports of Egyptian cotton for the 12 months ended July 31, 1915, amounted to the equivalent of 252,373 bales of 500 pounds each, as compared with 138,579 bales for the year ended July 31, 1914.

American manufacturers largely as a substitute for American long-staple Uplands of corresponding lengths, the substitution being profitable when the price of American long-staple cottons is relatively high. There is also a certain amount of substitution of the longest Egyptian, especially of the Sakellaridis variety, for the shorter lengths of Sea Island cotton, depending upon the relative prices of the two types. There remains, however, a large proportion of the imported Egyptian cotton for which no other fiber has yet been successfully substituted.

In view of this fact, the question has been frequently asked whether Egyptian cotton could not be produced in the United States in sufficient quantity to supply at least a part of the home demand. Conditions which have arisen in Egypt since the first attempts were made to answer this question have emphasized the importance of undertaking the production of Egyptian cotton in this country. It has been found that the maintenance of a uniform quality of any of the Egyptian varieties is rendered precarious by the fact that in Egypt distinct varieties are often grown in adjacent fields. There is also a general contamination of the whole Egyptian crop with an inferior and distinct type of cotton known locally as Hindi.

These conditions make it almost impossible to maintain in Egypt a supply of pure seed of a variety which has reached the stage of commercial production, because all these types of cotton cross freely with each other and adequate precautions are seldom taken to keep the seed of the different kinds separate at the gin. Furthermore, the cotton crop of Egypt suffers severely from insect enemies, notably in recent years from the ravages of the pink bollworm. This pest threatens a serious reduction of the crop, or at least a wide fluctuation in total production from year to year. Thus, it appears unsafe for the numerous American users of this type of cotton to depend solely upon Egypt for their supply of raw material, and the desirability of developing an independent source of supply in the United States is emphasized.

PRODUCTION OF EGYPTIAN COTTON IN AMERICA.

Although experiments with the production of Egyptian cotton in the southwestern United States were begun in 1902, it was not until 1912 that it was deemed advisable to recommend the commercial production of the crop. In the spring of that year seed was distributed by the Department of Agriculture to a number of farmers in the Salt River Valley in Arizona and the Imperial Valley in California. As a result of this distribution about 480 acres of cotton were brought through to harvest, and the crop of 1912 amounted to 375 bales of 500 pounds each.

In 1913 the production of Egyptian cotton was confined to the Salt River Valley, where a total of 3,800 acres was planted. Not all of this acreage came to harvest, but the crop for the year amounted to 2,135 bales of 500 pounds each.

In 1914 the area planted in the Salt River Valley amounted to approximately 12,000 acres. On much of this area the conditions were not favorable for large yields because of deficient soil fertility, inadequate preparation of the land, or faulty management of the irrigation. The total crop for the year amounted to 6,187 bales of 500 pounds each. While the average yield per acre shown by these figures is not high, a number of farmers having good land and using good methods obtained more than one bale per acre.

The status of the industry during the first three years of its existence is summarized in Table III.

TABLE III.—*Number of bales, estimated value of the lint, and estimated value of the seed of Egyptian cotton produced in the United States in the years 1912, 1913, and 1914.*[1]

Year.	Cotton lint in 500-pound bales.	Estimated value of lint.	Estimated value of seed.	Estimated total value of crop.
1912	375	$39,000	$5,000	$44,000
1913	2,135	197,000	28,000	225,000
1914	6,187	483,000	50,000	533,000

[1] Since 1913 the production of Egyptian cotton has been confined chiefly to the Salt River Valley in Arizona. A small quantity was produced in 1914 in the vicinity of Tucson, Ariz., but this is not included in the table.

Four ginning establishments, devoted exclusively to ginning Egyptian cotton, have been erected in the Salt River Valley. Each of these is equipped with 10 roller gins. The establishments are located in the towns of Phoenix, Tempe, Mesa, and Chandler. There are also two oil mills located at Phoenix, which press the seed of the Egyptian cotton crop of Arizona.

In staple and quality of fiber the American-grown Egyptian cotton is comparable with the best varieties produced in Egypt, and especially with the Jannovitch and Sakellaridis. The crops so far produced have also been of very good grade, comparing favorably with that of the best imported cotton. A large portion of the Egyptian cotton imported into the United States is of low grade or of relatively short staple, i. e., $1\frac{1}{4}$ to $1\frac{3}{8}$ inches. The American-grown Egyptian cotton does not come into competition with the latter class, but only with the better and higher priced varieties. However, the quantity of high-priced Egyptian cotton at present imported by American manufacturers very much exceeds the quantity likely to be produced in this country in the near future.

FUTURE POSSIBILITIES OF THE INDUSTRY.

Because of the low prices prevailing in 1914 only about 3,700 acres were planted to Egyptian cotton in the Salt River Valley in 1915. This check in the expansion of the industry is not to be regarded as wholly a disadvantage, since a continued rapid increase of the acreage might tax the resources of the growers' associations in providing sufficient pure seed for planting and in obtaining the labor necessary for prompt picking.

As to the ultimate possible extension of the industry, leaving out of consideration other localities where the climatic and soil conditions are favorable to the production of this crop, the Salt River Valley could produce as much as 50,000 acres annually. This is likely, however, only if prices remain at the average level of recent years and the supply of labor required for picking so large an acreage is obtainable. This is about the maximum acreage of cotton which a well-balanced agriculture in the Salt River Valley would permit unless the total acreage now under irrigation should be materially extended. The area of the Salt River Reclamation Project for which water is at present available is approximately 200,000 acres.

In view of the results obtained during the past three years, it appears to be conservative to estimate that 50,000 acres of land which have been enriched by crops of alfalfa and which are managed by farmers who have acquired experience in the best methods of growing Egyptian cotton would be capable of producing one bale per acre, or 50,000 bales from the entire area.[1] This quantity of cotton, selling at approximately 20 cents per pound, f. o. b. valley points (which is a reasonable figure if we consider the prices at which Egyptian cotton of corresponding quality has sold in the United States during the last 20 years), would yield to the growers approximately $5,000,000 annually.

The foregoing statement refers to prospective production in the Salt River Valley, the only section of the United States in which Egyptian cotton has as yet found place as an established industry. It is not to be expected that this type of cotton can be produced commercially east of the Rio Grande, but there are other localities in the southwestern United States where the crop might be grown if economic conditions should justify a further extension of the acreage. It has been demonstrated through repeated experiments that the crop may be grown on the Yuma Reclamation Project on the lower Colorado River, which includes 100,000 acres, and in the Imperial

[1] This estimate presumes an average yield comparable to that hitherto obtained only by the more successful growers, but there is every reason to expect that with additional experience and more skill in handling the crop the average yields may be greatly increased.

Valley, Cal., which includes about 500,000 acres. If 20 per cent of the land in these two sections were to be used for Egyptian cotton, it is estimated that 100,000 bales might be produced annually, in addition to the 50,000 bales which the Salt River Valley could supply. While the production of Egyptian cotton appears to be possible to the extent indicated here, it seems unlikely that this crop will be grown in the Imperial and Yuma Valleys in the near future.

COMPARISON OF AMERICAN AND EGYPTIAN CONDITIONS.

The commercial production of Egyptian cotton in the United States involves the marketing of the product in direct competition with the crop of Egypt. This fact warrants a brief consideration of the status of the cotton industry in that country and a comparison between the conditions there and in the southwestern United States.[1] The production in Egypt of cotton having a staple comparable with that of the Salt River Valley product is limited to what is known as Lower Egypt, that is to say, the Nile Delta, north of Cairo. This region includes about 3,250,000 acres of irrigated land, of which about 40 per cent is annually devoted to cotton, with an average yield of about 450 pounds of lint per acre.

This land is heavily capitalized, and the cost of irrigation water is high. These features are best expressed by rental values, which range for the best land from $50 to $75 a year per acre. It is probable that the average rental value of land in Lower Egypt is not far from $40 per acre, or at least twice the rental value of land in Arizona having similar capabilities of crop production.

While the cotton growers of Arizona have the advantage in respect to land rental or interest on land investment, those of Egypt are able to get their cotton picked at much less cost, owing to the cheapness and abundance of labor in that country. Aside from these two items, the cost of production is probably not very different in the two countries, since the low wage paid to farm laborers in Egypt is offset by the fact that the American farmer works with large fields and uses horse-drawn implements extensively. Much of the Egyptian crop, on the other hand, is grown by peasant farmers in small fields and with the use of very primitive implements.

The Egyptian industry suffers two serious disadvantages which do not exist in Arizona. One of these is the difficulty of maintaining pure seed, due to the widespread occurrence of Hindi, or "weed," cotton, which is discussed more in detail elsewhere in this paper. The other is the existence of certain insect pests, notably the pink

[1] For a more detailed discussion of the physical conditions in Egypt and in the southwestern United States, see Kearney, T. H., and Peterson, W. A., Egyptian cotton in the southwestern United States, U. S. Dept. Agr., Bur. Plant Indus. Bul. 128, 71 p., 2 figs., 5 pl., 1908.

bollworm, which have recently caused serious and extensive damage in Lower Egypt and which are still spreading.

It is probable that the higher valuation of land in Egypt, together with the less efficient methods of tillage, nearly or quite offsets the higher cost of labor in the United States. The crop-producing capabilities of the land in the two regions are much the same. The commercial value of the Arizona crop compares favorably with the best of the Egyptian crop and is much greater than the average value of the crop of that country. Finally, the Egyptian cotton grown in Arizona is practically free from Hindi contamination, and the pink bollworm has not yet found its way into the American fields.

In the matter of transportation the Egyptian cotton crop enjoys certain natural advantages over the product of the new American industry. It also has the advantage of long-standing occupation of the market and of a well-organized, though rather expensive, system of commercial distribution.

The entire Egyptian crop is assembled in Alexandria, where it is sorted, classed, compressed, and forwarded. Practically none of the cotton is manufactured locally. This centralization of the marketing business permits, though it does not insure, efficiency and economy in the handling of the product. The freight rates from Alexandria to manufacturing centers, transportation being by water, are low in comparison with the rates from Arizona, which include a long rail shipment. Freight rates, particularly ocean freight rates, are subject to continual fluctuations, but it is probable that the rates from Arizona to manufacturing points in either America or Europe are about three times as high as from Egypt to the same points.[1]

The large volume of the Egyptian crop and the centralized methods of handling also permit a standardization of types and a system of future selling against these types which are very important commercial advantages. To find favor in the market a consignment of cotton must not only show good grade and good staple, but must represent a type which has had its merit established through actual use. A manufacturer having determined what types of cotton meet his particular requirements will endeavor to duplicate these types in his annual purchases. For this reason Egyptian brokers establish definite types and maintain them from year to year. This system of dealing on types is possible with the Egyptian crop in spite of the continued deterioration of the varieties, because each broker has a large volume of cotton offered to him at Alexandria from which to select his stocks.

[1] The Arizona cotton is usually shipped by rail to Galveston, Tex., and thence by water to New England. The freight rate on baled cotton from Salt River Valley points to New England is about $1.30 per 100 pounds, this rate including the charge for compressing in transit.

The American growers will need to recognize this feature of the market for Egyptian cotton if they expect to secure full value for their product. While the American crop remains small, it is of the utmost importance that the quality be kept uniform from year to year.

It is possible to maintain this uniformity of type in the American crop if the growers exercise proper care in the selection of seed for planting. Unless the seed is selected carefully and consistent effort is made by good tillage and careful picking to maintain uniformly high quality in the crop, it will be difficult, if not impossible, to maintain the new industry on a profitable basis.

EARLY ATTEMPTS TO ESTABLISH EGYPTIAN-COTTON GROWING IN THE UNITED STATES.

The Department of Agriculture on several occasions prior to 1900 imported seed of Egyptian cotton and distributed it in small lots to farmers throughout the cotton belt. This procedure did not result in establishing the industry in any locality, a fact that ceased to be surprising when the necessity for community action in the commercial production of a new type of cotton came to be appreciated. The tests of the imported seed in various localities gave varying results as to yield and quality of the fiber produced, but serious difficulties were always encountered in communities where Upland cotton was already being grown. Some of these difficulties may be stated as follows:

(1) Pickers disliked the small bolls, which made it appear that picking would be much more difficult and expensive than in the case of the big-bolled Upland types which are generally popular in the South.

(2) Only saw gins were available for separating the fiber from the seed, and as a result the fiber was invariably injured in ginning.

(3) Marketing small lots of a new type of fiber, with which the local buyers were unfamiliar, was found to be extremely difficult.

(4) The Egyptian cotton was grown in the neighborhood of fields of Upland cotton, and consequently it was found impossible to keep the seed pure.

The seed of several of the best varieties grown in Egypt was imported in larger quantities by Mr. David Fairchild following his visit to that country in 1900 as an agricultural explorer for the Department of Agriculture.[1] Dr. H. J. Webber, then in charge of the plant-breeding work with cotton in the Department of Agriculture, undertook systematic tests of these varieties during the next two or three years at various localities in the cotton belt and in irrigated districts of the Southwest. In the main cotton belt fairly favorable

[1] The first planting of Egyptian cotton in Arizona appears to have been made with some of this seed, which was sent to Dr. A. J. Chandler, of Mesa, Ariz. This was a year or two before the beginning of experimental work with this crop in Arizona by the Department of Agriculture.

results were obtained in certain localities, but owing to the difficulties mentioned the experiments did not result in the establishment of commercial production.

BEGINNING OF EXPERIMENTS IN THE SOUTHWEST.

The irrigated lands of southern Arizona and southeastern California, where the climatic conditions more nearly resemble those of Egypt than in the cotton belt, were found to offer the most promising field for the introduction of this type of cotton. In the early stages of the work, however, serious difficulties were encountered in this region also. The most important of these were the following: (1) The lack of proper facilities for carrying on the plant-breeding work and the investigations of cultural methods; (2) lack of uniformity in the imported stocks of seed and slow progress in the development of a productive type having fiber of sufficiently good quality and uniformity to warrant its recommendation for commercial production; and (3) lack of information as to the proper methods of irrigation and culture under the climatic and soil conditions of the region.

It also became apparent that, even if these cultural difficulties could be overcome, certain economic problems would need to be solved before commercial production could be undertaken with any hope of success. These problems were as follows: (1) The scarcity and high price of labor in this thinly populated region, which threatened to make the picking so expensive that no profit could be anticipated; and (2) the difficulty of ginning and marketing the crop grown in a small way by farmers in localities remote from established cotton markets.

The first-mentioned difficulty was overcome when the Department of Agriculture established two well-equipped experiment farms where the plant-breeding work and the study of cultural methods could be carried on from year to year on the same soils and under the same management. These farms are the Cooperative Testing and Demonstration Garden at Sacaton, Ariz., with Mr. E. W. Hudson as superintendent, conducted by the Office of Crop Physiology and Breeding Investigations in cooperation with the Office of Indian Affairs, Department of the Interior, and the experiment farm at Bard, Cal., on the Yuma Reclamation Project, formerly in charge of Mr. W. A. Peterson and at present under the superintendence of Mr. R. E. Blair, conducted by the Office of Western Irrigation Agriculture in cooperation with the United States Reclamation Service.[1]

[1] Mr. Argyle McLachlan served for several years as field agent of the Department of Agriculture in the Southwest, and while his attention was devoted mainly to the Durango-cotton industry in the Imperial Valley, he also aided effectively in the work with Egyptian cotton in the Salt River Valley.

UNSATISFACTORY CHARACTER OF THE ORIGINAL STOCKS.

During the earlier years of the breeding work in Arizona the behavior of the plants was very unpromising. They made an extremely rank growth, but were relatively unfruitful and late in maturing. The bolls were small and often opened imperfectly. There was also a pronounced lack of uniformity in the imported stocks and in the strains which were first selected from them.[1]

Mr. O. F. Cook, as a result of observations upon Egyptian varieties grown in Arizona from newly imported seed, reached the conclusion that the difficulty in obtaining uniformity was largely attributable to the presence among the Egyptian stocks of a very different and inferior type of cotton, the Hindi, the resulting cross-pollination having led to serious contamination of the Egyptian varieties. The matter seemed of sufficient importance to warrant an investigation in Egypt by Mr. Cook in 1910. The degree of Hindi contamination observed in that country was surprisingly great.[2]

Nearly every cotton field inspected was found to contain Hindi plants, and in some fields as many as 20 per cent of the plants were of the Hindi type. The percentage of pure Hindi plants does not represent the full extent of the damage, since this type crosses readily with the Egyptian cotton and the final result is a series of hybrids possessing in varying proportions the characters of each parent. Commencing with a mixed population of this sort, a uniform cotton can be developed only by the selection of an individual plant which possesses the characters desired and which breeds true, thus permitting the segregation of a pure stock.

Even if there were no Hindi cotton in Egypt, the conditions would be unfavorable for the maintenance of uniform varieties, since a number of distinct types of Egyptian cotton are grown, often in adjacent fields, and the pollen is readily carried from field to field by insects, leading to the production of intervarietal hybrids. Furthermore, until very recently no adequate precautions were taken to avoid the mixing of seeds at the gins.

DEVELOPMENT OF MORE UNIFORM VARIETIES.

Success in the effort to obtain a variety which could safely be recommended for commercial production was not attained until the variety called "Yuma" was segregated in 1908.[3] Although selected

[1] Cook, O. F., McLachlan, Argyle, and Meade, R. M. A study of diversity in Egyptian cotton. U. S. Dept. Agr., Bur. Plant Indus. Bul. 156, 60 p., 6 pl. 1909.

[2] Cook, O. F. Hindi cotton in Egypt. U. S. Dept. Agr., Bur. Plant Indus. Bul. 210, 58 p., 6 pl. 1911.

[3] For a more complete description of this variety and a more detailed account of its history, see Kearney, T. H., Breeding new types of Egyptian cotton, U. S. Dept. Agr., Bur. Plant Indus. Bul. 200, 39 p., 4 pl., 1910. See also Kearney, T. H., Mutation in Egyptian cotton, in Jour. Agr. Research, v. 2, no. 4, p. 287–302, pl. 17–25, 1914.

from a stock of Mit Afifi, the Yuma cotton is very distinct from that variety in the characters of the plants and of the fiber. The lint averages $1\frac{1}{2}$ inches in length (ranging, under different cultural and soil conditions, from about $1\frac{7}{16}$ to about $1\frac{9}{16}$ inches) and has the pale pinkish buff color of the Jannovitch rather than the deeper buff color of the Mit Afifi. The lint percentage averages about 28.

Yield tests and spinning tests of the Yuma cotton carried on during several years demonstrated that a stable variety, uniform in its characters and producing fiber of good spinning quality, had at last been obtained. Seed was therefore placed in the hands of farmers in the Salt River and Imperial Valleys in 1912, with the results described on preceding pages.

From the Yuma variety there has originated another very distinct new type, which has received the name "Pima" and which surpasses the parent variety in productiveness, size of the bolls, and length and quality of the fiber. Yield tests of the new variety and spinning tests of its fiber are now in progress, and if the results bear out the early promise it may be advisable to substitute this variety for the one which is now grown commercially.

MAINTAINING THE PURITY OF THE VARIETY.

The immediate progeny of the individual plant from which the Yuma variety originated was remarkably uniform, except that about 8 per cent of the plants were evidently first-generation hybrids. The presence of these hybrids could readily be explained by the fact that some of the flowers on the parent plant had been fecundated with pollen from surrounding Egyptian cotton plants containing more or less Hindi blood and from Upland cotton plants grown near by. Seeds from the apparently nonhybrid plants in this progeny were used to plant a 4-acre field of the Yuma variety in 1909. Although these plants had shown only the characters typical of the new Yuma variety, about 2.5 per cent of their progeny of 1909 exhibited, more or less distinctly, Hindi or Upland characters. All such plants were rogued out of the field early in the summer, at about the time blossoming commenced.[1]

The vegetative characters of the Yuma variety are distinctive and the recognition of hybrids is comparatively easy. It is therefore practicable to remove most of the "off-type" plants at a sufficiently early stage of their development to prevent their crossing with the typical plants. Careful roguing of the seed-increase fields year after year

[1] The importance of the early roguing of cotton fields intended to furnish seed for planting and the feasibility of recognizing the "off-type" plants in the early stages of growth have been pointed out by Mr. O. F. Cook. (Cotton selection on the farm by the characters of the stalks, leaves, and bolls. U. S. Dept. Agr., Bur. Plant Indus. Circ. 66, 23 p. 1910.)

has made it practicable to maintain thus far a satisfactory degree of uniformity in the variety.

SOLVING THE PROBLEMS OF COMMERCIAL PRODUCTION.

As the work of establishing the new industry progressed it became apparent that the economic and agricultural problems could best be met by enlisting the cooperation of several men representing different lines of experimental work in the Department of Agriculture, each of whom was able to contribute special knowledge and experience. The cooperation was at first informal, but later, as the responsibilities increased, it was thought advisable to create a special committee to carry on this work. A "Committee on Southwestern Cotton Culture" was therefore appointed in 1910 by the Chief of the Bureau of Plant Industry.[1]

It has been the policy of the committee since its organization to avoid a sharp segregation of the different fields of investigation. As a result, each member has felt free to offer suggestions and even to assume responsibility beyond the limits of his own field, while the more important issues which have successively arisen in connection with the establishment of the industry have been decided by the whole committee. It is believed that this committee cooperation has been of the greatest importance in the successful establishment of the industry, since it has resulted in focusing upon the problems the different points of view and different mental equipment and training of several independent investigators.

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[1] The following is the personnel of the committee:

C. S. Scofield, Agriculturist in Charge of Western Irrigation Agriculture. Mr. Scofield is chairman of the committee, and in addition has charge of those phases of the work which involve cooperation with the United States Reclamation Service. He has also conducted certain investigations of market conditions in the United States and in Europe.

W. T. Swingle, Physiologist in Charge of Crop Physiology and Breeding Investigations. Mr. Swingle has charge of those phases of the work which involve cooperation with the Office of Indian Affairs, including the arrangements for securing Indian labor. The Cooperative Testing and Demonstration Garden at Sacaton, Ariz., where plant-breeding work with cotton is now centered, is under Mr. Swingle's direction. Mr. E. W. Hudson, superintendent of this garden, has taken a very active part in the establishment of the industry and has been in constant touch with the growers in the Salt River Valley.

O. F. Cook, Bionomist in Charge of Crop-Acclimatization and Cotton-Breeding Investigations. Mr. Cook conducts investigations of the factors involved in the acclimatization of different types of cotton in the Southwest and of the relation of these factors to cultural methods. He has also taken the lead in developing the idea of community cotton growing as a means to the maintenance of uniform varieties.

T. H. Kearney, Physiologist in Charge of Alkali and Drought Resistant Plant Investigations. Mr. Kearney has charge of the breeding work with Egyptian cotton and of the investigations of the effect of alkali and other soil conditions upon the production of this crop.

C. J. Brand, Chief of the Office of Markets and Rural Organization. In 1912, when the problem of marketing the first commercial crop became acute, Mr. Brand, at that time in charge of the cooperative cotton handling and marketing investigations of the Bureau of Plant Industry, became a member of the committee. Mr. Brand has charge of the investigations in classing, marketing, and transportation.

Cooperative action having thus been provided, the economic problems were attacked as follows:

(1) The principle of community action in cotton production, being thoroughly recognized, was successfully applied in the organization of associations of growers through which the problems of cooperative ginning and marketing were solved.

(2) A very satisfactory supply of labor was developed through the employment of Pima and Papago Indians as cotton pickers, the first experiments having been made at the Cooperative Testing and Demonstration Garden at Sacaton, under Mr. Swingle's direction.

(3) Methods for classing the new product were worked out and a series of grade types was established, under Mr. Brand's direction, by Mr. J. G. Martin, investigator in cotton marketing.

(4) The American and European markets for this type of cotton were investigated by representatives of the associated growers and of the Department of Agriculture, contacts with buyers and spinners were established, and outlets for the product on the basis of full market value were thus assured.

(5) In cooperation with the associated growers, measures were taken to insure a supply of pure seed for planting each year.

COOPERATIVE ORGANIZATION OF THE GROWERS.

When the Yuma variety of Egyptian cotton developed by the Department of Agriculture had been shown to possess the qualities needed for successful commercial production, it was pointed out that the industry could be successfully established only by community action and that the department stood ready to furnish a supply of seed for planting, provided the growers were able to form a cooperative association. Farmers in the Salt River Valley had watched with interest the experiments with Egyptian cotton at Sacaton and had conferred with the superintendent of the cooperative garden there regarding the outlook for commercial production and the methods of growing the crop. They were therefore ready to adopt the point of view of the department, and in the spring of 1912 about 30 farmers in the vicinity of Mesa organized an association. In the following year similar organizations were formed at Chandler and Tempe. Finally, in the spring of 1914, a central organization, known as the Salt River Valley Egyptian-Cotton Growers' Association was formed, with the Mesa, Chandler, and Tempe associations as its constituent members. The central organization was designed to look after the marketing of the crop and the maintenance of a supply of pure seed for the entire valley, while the local organizations continued to provide for the ginning of the cotton grown by their members and for financing the crop during the growing period.

The Mesa and Tempe associations now operate well-equipped ginning plants. The gin at Chandler has been leased and operated by a private company, and there is also a privately owned ginning plant at Phoenix.

The organization of the cotton growers of the Salt River Valley is still far from complete, since in 1911 only about 40 per cent of the total acreage of Egyptian cotton was represented in the central association. It is not likely, nor is it necessary to the success of the industry, that all of the growers in a community will become active members of the cooperative growing and marketing associations, but it is of the utmost importance that all should adhere to the policy of the organizations as regards the production of a single variety and the use of carefully selected seed. The commercial reputation of the cotton produced in the region, and hence the best interests of every individual cotton grower, can be secured only by this means.

LABOR FOR PICKING.

From the beginning of the experiments with Egyptian-cotton production in the Southwest it has been realized that the high cost of picking would be one of the most difficult problems to overcome. Hand labor is neither abundant nor cheap in these southwestern irrigated districts, yet a cheap and abundant supply of hand labor has generally been regarded as essential to successful cotton production. Picking Egyptian cotton requires greater care and is more expensive than picking Upland cotton, owing to the smaller size of the Egyptian bolls and the necessity of avoiding an admixture of such trash as leaves and pieces of bolls. In picking long-staple cotton it is especially important to keep the seed cotton clean; otherwise the grade of the lint is impaired and its selling value is much reduced. The cotton growers of the Salt River Valley have had to pay for picking at the rate of $2 per 100 pounds of seed cotton, while in the Imperial Valley, where big-bolled types of cotton are grown, the prevailing rate has been $1 per 100 pounds.

Notwithstanding these natural disadvantages, the problem of picking the crop of the Salt River Valley has been met successfully. It has been found that pickers could make satisfactory wages when paid at the rate mentioned. Although the industry has developed rapidly, no serious shortage of labor has yet been experienced. This has been due to the fact that the growers, through an active organization, have attacked the problem in a businesslike way. In the first place, many of the farmers had only small acreages and they and their families were able to do most of the picking. This distribution of the acreage among small farmers is very desirable and should be encouraged. There remained, however, a large acreage for which pickers had to be secured, in addition to the home supply of labor. For this purpose the floating population of the valley was drawn upon and Indians were brought in from near-by reservations.

There are two tribes of Indians in southern Arizona which include a large number of industrious and capable workers. The Pimas, who

occupy a reservation adjoining the Salt River project, have taken up cotton growing to some extent on their own lands and have also been employed as cotton pickers by the white settlers. The Papagos occupy a large tract of land lying south of the Pima Reservation. There are several thousands of these Indians, and as they lead a rather nomadic existence because of the uncertainty of the desert water supply, they find a season of cotton picking a congenial method of employment and have taken to it readily. Last year several hundred of them were engaged in the work throughout the picking season, with very satisfactory results to themselves and to the cotton growers.[1]

The present indications are that if the cotton acreage in the Salt River Valley does not increase too rapidly and if the growers continue to give the problem the attention it deserves, there will be no serious shortage of pickers. While the cost of picking is high, the other costs of production are not excessive, and if the yields are good the value of the crop is sufficiently great to carry the picking cost and leace a satisfactory margin of profit to the grower.[2]

COMMUNITY CREDIT FOR FINANCING THE CROP.

The production of cotton in a new region involves some arrangement for financing the crop until it can be sold. The expenses of production up to the time of picking are not much greater than with other farm crops, but ordinarily the pickers must be paid promptly, and the cost of picking, together with the cost of ginning, requires an outlay of funds greater than farmers can ordinarily meet without special credit arrangements. This is particularly true when cotton growing is being undertaken in a new region, because the marketing of the crop takes more time than when the industry is well established. Under such conditions the crop can rarely be sold as soon as it is ginned. It must be classed and assembled into uniform lots, and must move to market gradually if the best prices are to be obtained. Even in the case of the well-established cotton industry in Egypt the crop moves to the market very gradually, much of it not reaching the manufacturer until the following spring or summer. Meanwhile, it must be financed.

[1] It is estimated that in 1913 about $20,000 and in 1914 about $37,500 was paid to Indians of the Papago and Pima tribes as wages for picking cotton in the Salt River Valley. These sums, in addition to what was derived from the sale of the crops grown on the reservation lands, indicate that the combined income from Egyptian cotton which accrued to the Indians of southern Arizona approximated $40,000 in 1913 and $50,000 in 1914.

[2] The extent to which the money brought into the locality by this new crop is distributed among the population is indicated by the estimate that during the picking season of 1914–15 a total of $150,000 was paid out in wages to cotton pickers in the Salt River Valley.

In view of the uncertainties attending the marketing of long-staple cotton from a new locality, brokers are not likely to risk paying what they believe to be the full value of the crop if asked to take it unclassed in round lots, as it comes from the gin. For that matter, even when they have the advantage of a well-established market, farmers would probably benefit by holding their cotton in storage until it can be classed into even-running lots and sold with the least element of risk to the cotton merchant or the spinner.

The associated growers in the Salt River Valley have met this problem of financing the crop by a plan of community credit. Arrangements were made with local banks to secure the necessary funds. Each bale of cotton, as soon as it was ginned, was placed in storage and a receipt was issued against it, these receipts being used as collateral for loans through the association. In this way it was possible for the grower to secure money to defray his expenses for picking and ginning without losing possession of his cotton until it was finally sold to the manufacturer. In the absence of such a system of community credit, it probably would have been necessary for the grower to sell his cotton as soon as it was ginned for whatever price he could obtain.

GINNING IN RELATION TO PRODUCTION.

The roller gin which is used for Egyptian cotton can not be operated as rapidly or as cheaply as the saw gin which is used for Upland cotton. The charge ordinarily made for ginning Egyptian cotton in the Salt River Valley is $10 per bale, which is more than twice as much as is charged for ginning Upland cotton in the South. The actual cost of ginning Egyptian cotton in Arizona is probably less than the figure specified, and is likely to be materially reduced through the adoption of certain improvements in the machinery.

Instead of depending upon custom ginning, two of the associations of cotton growers in the Salt River Valley operate their own plants. The experience of these farmers, which is in accord with that of farmers in the eastern cotton belt, indicates that the best results are obtained when the ginning is under the control of the producers. The market value of cotton may be very greatly reduced by careless ginning, and when the gin operator has no other interest than to secure the largest possible outturn, the commercial value of the product is likely to be impaired.

Cotton ginning is a technical operation, which requires experience and skill to secure the best results. The cooperative ownership and management of a gin by the growers does not in itself insure capable and efficient management, but it does afford the owners of the crop an opportunity to insist upon the work being properly done. This

opportunity is seldom afforded when the cotton is handled by custom gins. In either case, it is of the utmost importance to the growers that the crop be classed or graded by a capable and impartial expert as soon as it leaves the gin. Prompt grading serves to warn the farmer if either the picking or ginning is being poorly done, and gives him this warning in time to enable him to secure better work.

The grower is interested in the way the ginning is done, not only because of its effect on the value of his lint, but also because of its relation to his supply of seed for planting. Where only uncontrolled custom ginning is available the grower has small chance of maintaining the purity of his seed.[1]

The opinion appears to be gaining ground among students of cotton production that the improvement of the industry depends fully as much upon good ginning as upon good cultivation or good picking. The surest way to obtain good ginning is by cooperative ownership and operation of the gins.

GRADING THE CROP.

It was pointed out on a preceding page that uniform grades of Egyptian cotton must be established and maintained from year to year if the crop is to find ready sale at its full value. In recognition of this fact steps were taken in 1913 to establish standards of the different types and grades produced in the crop of that year. A cotton-grading expert was detailed from the Office of Markets and Rural Organization to cooperate with the growers' association for this purpose. The work was continued in 1914, the standards having been perfected and arrangements having been made for spinning tests, in order that the cotton might be placed on a sound basis of market value. The scope and results of this standardization work are given in a report from the Office of Markets and Rural Organizations.[2]

MARKETING THE CROP.

Notwithstanding the facts that the Egyptian type of cotton has not been grown previously on a commercial scale in the United States and that the Salt River Valley is a new cotton-growing locality, comparatively little difficulty has been experienced thus far in disposing of the product. This is due largely to the cooperative action of the growers in grading and marketing their cotton, which has made it possible for them to offer it in uniform lots of sufficient size

[1] Experiments that demonstrate in a striking manner the readiness with which seeds of different varieties of cotton become mixed in commercial ginning establishments have been described recently by D. A. Saunders and P. V. Cardon. (Custom ginning as a factor in cotton-seed deterioration. U. S. Dept. Agr. Bul. 288, 8 p., 5 fig. 1915.)

[2] Martin, J. G. The handling and marketing of the Arizona-Egyptian cotton of the Salt River Valley. U. S. Dept. Agr. Bul. 311, 16 p., 3 pl. 1915.

to interest the buyers. Another factor has been the willingness of progressive manufacturers who recognize the need of developing new sources of long-staple supply to purchase and try out this cotton while its production was still in the experimental stage.

The few hundred bales produced in 1912 were readily disposed of at good prices, being purchased by a firm of thread manufacturers. In 1913 the dull condition of the cotton market and the lack of established contracts between the growers' associations and the spinners of staple cottons retarded the disposal of the much larger crop. The portion of the crop controlled by the associated growers was, however, finally sold on satisfactory terms through a large international firm of cotton buyers, which sent an agent to Arizona to superintend the purchase and shipment of the crop.

In 1914 the same cotton-buying firm, which has shown a constructive interest in the development of Egyptian-cotton growing in the Salt River Valley, again handled a large proportion of the crop, and it was moved out promptly, either on actual sale or on consignment, as fast as it was ginned and classed. On the other hand, some of the individual growers who did not belong to the cooperative associations experienced difficulty in disposing of their cotton.

It should be noted that ever since the establishment of the industry the crop has been sold each year in open competition with the vastly larger crop produced in Egypt. The effective organization of the Arizona growers and the intelligent application of the best principles in growing, handling, and marketing the crop and in maintaining the seed supply are largely responsible for this satisfactory result.

MAINTENANCE OF THE SEED SUPPLY.

It was pointed out in an earlier publication[1] what steps should be taken by the associated growers and what kind of assistance the Department of Agriculture could furnish in guarding against the deterioration of the seed used for planting.

The growers having signified their desire to cooperate with the department along these lines, experts were detailed during the summer of 1913 to rogue a limited acreage of well-grown cotton in order to obtain seed for increase during 1914 and for general planting in 1915. In 1914 the department's experts, assisted by representatives of the Salt River Valley Egyptian-Cotton Growers' Association, rogued about 100 acres which had been planted with seed from the fields which were rogued in 1913. Every plant in this acreage was examined, and the unproductive and off-type plants, amounting to about 1 per cent of the total, were removed. The

[1] Kearney, T. H. Seed selection of Egyptian cotton. U. S. Dept. Agr. Bul. 38, 8 p. 1913.

work was done early in July, soon after blossoming began, in order to take out the inferior plants before their pollen should contaminate those left in the field. Of the cotton grown from seed produced by fields which were rogued in 1914, about 100 acres were rogued during the summer of 1915, somewhat less than 1 per cent of the plants being removed.

The association undertakes to have the seed from the rogued fields ginned under such conditions as to avoid mixing with other seed and also to have the seed sacked and tagged as it comes from the gins, in order to prevent mixture while it is held in storage. The rogued seed is placed by the association in the hands of careful farmers having good land sufficiently remote from other cotton to prevent crossing. The fields planted under these conditions are inspected during the summer, and the product of those which are properly grown and are otherwise satisfactory is ginned separately, in order to furnish seed for general planting the second year after the roguing is done. Thus, the seed used for general planting in 1916 will be derived from the fields which were rogued in 1914, and that which is used for general planting in 1917 will be derived from the fields rogued in 1915. It is believed that the seed from inspected fields can be sold for planting at a price very little above current oil-mill prices, thus removing the temptation to plant unselected seed because it is cheaper.

If the growers' association follows year after year the plan thus outlined it is to be expected that deterioration, if it occurs, will be so gradual that there will be time for the substitution of a pure strain selected and multiplied at the plant-breeding station.

AGRICULTURAL RELATIONSHIPS OF THE CROP.

The outstanding agricultural feature of cotton production in Arizona is the value of the crop in the farm rotation. Alfalfa, which occupies more than half the irrigated land in the Salt River Valley, is the basis of the agriculture of that locality; but the alfalfa fields after a few years become so badly infested with Bermuda grass and other weeds that their value is greatly impaired. It has been found that these old alfalfa fields, when thoroughly broken up and worked into good tilth, yield large crops of cotton. At the same time the intertillage of the cotton crop while the plants are young and the complete shading of the ground later in the summer effectually rid the land of weeds. One or two well-tilled crops of cotton following alfalfa will leave the land clean and in excellent condition for reseeding with alfalfa or for growing other crops. Because of its renovating value in the farm rotation, cotton is a valuable crop for the Salt River Valley, quite aside from the cash returns it brings.

Less water is needed for the production of cotton than for the production of alfalfa, particularly early in the season. In fact, the total seasonal quantity of water needed for irrigating cotton is probably not much more than half that needed for the irrigation of alfalfa. The significance of this point lies in the fact that there is more irrigable land in the Salt River Valley than can be supplied with irrigation water. Hence, the growing of a crop which permits economy of the water supply may permit the ultimate extension of the irrigated area.

A portion of the irrigated land in the Salt River Valley has been damaged by the excessive irrigation of alfalfa, which has resulted in the land becoming swampy. While this trouble has not been serious, it has occasioned anxiety on the part of certain landowners and has necessitated the formulation of plans for a drainage system. The growing of cotton on these areas tends to reduce the danger of waterlogging.

Another advantage of cotton as a crop for the irrigated Southwest is the fact that the product is a staple and nonperishable commodity. Practically all of the other crops yielding high cash returns per acre are perishable and involve the hazard of heavy losses if the market is temporarily oversupplied. Cotton, on the other hand, is not subject to rapid deterioration if not sold promptly.

COST OF PRODUCTION.

In an earlier report on the Egyptian-cotton industry in the Southwest,[1] the various factors involved in the cost of production were discussed, and the conclusions stated were as follows:

> The cost of producing an acre of Egyptian cotton, estimating a yield of 1,800 pounds of seed cotton per acre, may be summarized as follows: Seed, tillage, and irrigation, $15; picking, $36; ginning and baling, $10; making a total cost of $61 per acre, exclusive of interest on land investment. It should be kept in mind that these figures are merely approximations. The actual costs will be found to vary between wide limits, both above and below these figures.

After two years' additional experience, an estimate of the cost of production has been prepared by Mr. W. S. Dorman, who has grown the crop for three years and who has also served as president of one of the local associations of growers, a position which has enabled him to keep in close touch with the progress of the new industry. Mr. Dorman's estimates are shown in Table IV.

From these estimates, which include the item of interest on the land investment and deduct the value of the seed produced, Mr. Dorman has calculated the net cost of production per pound of lint

[1] Scofield, C. S. Egyptian cotton culture in the Southwest. *In* U. S. Dept. Agr., Bur. Plant Indus. Circ. 123, p. 21–28, 2 fig. 1913.

as 16.54 cents when the yield is two-thirds of a bale per acre, and 13.65 cents when the yield is one bale per acre.

TABLE IV.—*Cost of producing Egyptian cotton in the Salt River Valley based on yields of two-thirds of a bale and 1 bale to the acre.*

Item of cost.	Cost per acre of—	
	Two-thirds of a bale.	One bale.
Plowing, preparing soil, cultivating, and seed	$15.00	$15.00
Irrigation water	1.50	1.50
Picking seed cotton	24.00	36.00
Transportation to gin	2.50	3.00
Ginning lint, at 2 cents per pound	6.72	10.00
Interest on $150 at 8 per cent	12.00	12.00
Total cost	61.72	77.50
Value of cotton seed at 75 cents per 100 pounds	6.15	9.26
Net cost of lint	55.57	68.24

The estimates given probably approximate very closely the average cost of producing Egyptian cotton in the Salt River Valley and show clearly the importance of securing large yields per acre if the industry is to be profitable. This fact is still further emphasized by the following statement (Table V) of the actual expenditures of a grower who, in 1914, produced cotton on a 40-acre field which yielded nearly 1½ bales per acre. The crop was produced entirely by hired labor.

TABLE V.—*Cost per acre of producing 40 acres of Egyptian cotton in the Salt River Valley in 1914.*

Item of cost.	Cost per acre.
Seed and tillage	$15.10
Irrigation water	2.00
Picking 2,552 pounds of seed cotton, at 2 cents	51.04
Ginning, insurance, yardage, and association expenses	15.98
Interest and taxes	17.25
Total cost	101.37
Receipts for cotton seed	10.32
Net cost per acre	91.05
Yield of cotton lint per acre, 736 pounds ; net cost of lint per pound .....cents..	12.37

[1] This figure of cost of production per pound of lint is not directly comparable with those arrived at by Mr. Dorman on the basis of yields of two-thirds of a bale and of one bale per acre, respectively, certain elements in the cost of production, notably land valuation (interest and taxes), having been differently estimated in the present instance.

This field gave one of the highest yields obtained in the Salt River Valley in 1914. It is a much larger yield than can be expected as an average from even the better lands. The figures are given here merely to indicate the importance of using the best methods of tillage

and irrigation if reasonable profits are to be obtained from the production of this crop. Even with the abnormally low prices obtaining last year, this farmer made a fair profit on his investment.

TILLAGE METHODS.

The best methods of preparing the land for Egyptian cotton and of irrigating and cultivating the crop have been worked out by Mr. E. W. Hudson, superintendent of the Cooperative Testing and Demonstration Garden at Sacaton, Ariz., and are described by him in a recent publication of the Department of Agriculture.[1]

The essential features of these methods consist in the early and thorough preparation of the land; careful leveling, so that the entire field can be irrigated uniformly; early planting; getting the seed into moist soil; late thinning; leaving the plants close together in the row; the sparing use of irrigation water until the plants blossom; thorough cultivation as long as the size of the plants permits; and frequent light irrigation after blossoming begins until the crop is fully matured.

LATE THINNING AND CLOSE SPACING.

The Egyptian-cotton plant makes a very luxuriant growth on the irrigated lands of the Southwest. Because of this fact, it was thought necessary at first to plant the rows wide apart (as much as 5 feet) and to thin severely, leaving the plants finally 2½ to 3 feet apart in the row. Under these conditions each plant attained a large size and produced several long vegetative branches, or "limbs." It was also customary at first to do the thinning, or "chopping" as it is called, when the plants were very small and had only two or three leaves in addition to the seed leaves. While this system of planting and thinning gave good yields, it was found that the crop was so late in maturing as to be in danger of frost injury in the autumn, and also that the large size of the plants and their numerous vegetative branches made the picking very difficult and expensive.

Closer investigation of the branching habits of the plant developed the fact that these troublesome vegetative branches could be suppressed by delaying the thinning until the plants are 8 to 10 inches high and have 10 to 12 normal leaves, and by leaving the plants closer together in the row.[2]

The best spacing distance for the plants has been found to depend somewhat upon local and seasonal conditions. Mr. E. W. Hudson

[1] Hudson, E. W. Growing Egyptian cotton in the Salt River Valley, Arizona. U. S. Dept. Agr., Farmers' Bul. 577, 8 p. 1914.

[2] These investigations were made by Mr. O. F. Cook and his assistants, and the details, of the investigations, as well as the cultural recommendations resulting from them, have been published in several bulletins and circulars, for the titles of which see the last section of this paper on the literature of the industry.

states that on rich alfalfa land and with irrigation properly managed 6 to 8 inches is about the right distance, while on new land the plants can safely be left 4 inches apart. The thinning should be done in such a way as to result in suppressing practically all of the vegetative branches without stunting the growth of the central stem or shading too much the lower fruiting branches.

This new method of delayed thinning and of closer spacing of the plants has resulted in securing a much earlier development of the crop, as well as in making the picking much easier and cheaper. The time and manner of thinning are so important that they merit the closest personal attention of the grower, the more so as it is impossible to lay down general rules which will be equally well suited to each type of soil and to each season.

UNDESIRABILITY OF RATOONING EGYPTIAN COTTON.

The winters of southern Arizona are often mild enough to allow many of the old cotton stumps to remain alive in the ground, and it is possible to grow a second crop from them. This has suggested the ratooning of Egyptian cotton, a practice which has recently had some advocates in the Salt River Valley. Ratooning was formerly practiced in Egypt, but the system was discontinued in that country because of the poor quality of the fiber produced. The practice has also been thoroughly tested with Durango cotton in the Imperial Valley, where the results were unsatisfactory.

While ratooning saves the labor of spring planting and results in the earlier maturity of the crop, it has no other advantage. A perfect stand can rarely be had, and the seedling plants with which the gaps must be filled ripen later than the ratooned plants and produce fiber of different length and quality, making it impossible to obtain a uniform product from the field. It is questionable whether the very early ripening of the ratooned cotton is really a benefit, since it necessitates picking during the hottest season of the year. It would also be difficult to keep the land from becoming weedy if this method were followed. Finally, the practice of leaving the old stumps in the ground would favor the increase of such injurious insects and fungi as might gain a foothold in the locality. The advisability of replanting the fields each year with the best seed obtainable can not be too strongly urged.

ENEMIES OF THE CROP.

Fortunately no very serious diseases or insect enemies of the crop have yet appeared in the Salt River Valley. A weevil, very closely related to the Mexican cotton boll weevil and capable of feeding upon and depositing its eggs in the bolls of cotton, is native to the mountains of southern Arizona, occurring on a wild plant somewhat

nearly related to the cotton plant.[1] Neither this weevil nor the true Mexican boll weevil has as yet been observed in the cotton fields of the Salt River Valley. An aphis commonly attacks the young plants, and in 1914 it persisted in large numbers until late in the summer, but it has not been shown that this insect causes serious damage to the crop. Bollworms occur in small numbers, but have not thus far been a source of appreciable damage. The dreaded pink bollworm, which has recently played havoc with the cotton crop of Egypt, has fortunately not yet been observed in the United States, and it is to be hoped that the measures taken by the Federal Horticultural Board will prevent its introduction.

Certain fungous diseases, while rather common, do not appear to be severely injurious. The seedling cotton plants are subject to attack, especially when cold weather occurs after planting, by a species of Rhizoctonia, causing the disorder known as "sore shin." When this disease is very prevalent, some replanting is likely to be necessary, but the plants which survive soon cease to show any effects of the trouble. Small areas, particularly in old fields which have previously been in alfalfa, are subject to a root rot, or wilt,[2] which toward the end of the summer causes the cotton to die rapidly in well-defined spots. The percentage of the total acreage thus affected is small, and the disease does not appear to spread rapidly through the soil or to be a serious factor in production when a suitable rotation of crops is followed.

The cotton seedlings are also subject to a disorder known as leaf-cut,[3] which is apparently a physiological derangement not associated with a parasitic organism. The symptoms are mutilation of the leaves and sometimes the abortion of the growing point of the stem, resulting in the malformation of the plants most seriously affected. Since the plants are subject to this disorder only while very young, the system of late thinning eliminates its effects by permitting the "chopping" out of the malformed plants.

CONDITIONS OF SUCCESSFUL EGYPTIAN-COTTON PRODUCTION.

The experience gained in connection with the establishment of the community growing of Egyptian cotton in the Salt River Valley makes it possible to formulate the conditions which appear to be indispensable to the successful production of this crop in the United

[1] Cook, O. F. A wild host plant of the boll weevil in Arizona. *In* Science, n. s., v. 37, no. 946, p. 259–261. 1913.

Bailey, Vernon. The wild cotton plant (*Thurberia thespesioides*) in Arizona. *In* Bul. Torrey Bot. Club, v. 41, no. 5, p. 301–306, 2 fig. 1914.

Coad, B. R. Relation of the Arizona wild cotton weevil to cotton planting in the arid West. U. S. Dept. Agr. Bul. 233, 12 p., 4 pl. 1915.

[2] The identity of this disease has not yet been established.

[3] Cook, O. F. Leaf-cut, or tomosis, a disorder of cotton seedlings. *In* U. S. Dept. Agr., Bur. Plant Indus. Circ. 120, p. 29–34, 1 fig. 1913.

States. These are, briefly, (1) a growing season of about nine months, or several weeks longer than is required to mature a full crop of Upland cotton; (2) a reliable supply of water for irrigation; (3) labor sufficient to pick the acreage planted; (4) absence of other types of cotton in the locality, as otherwise pure seed and a uniform fiber can not be maintained; (5) an acreage sufficient to warrant the purchase of roller gins and other equipment and the employment of a competent classer, in order to market the cotton in even-running lots of commercial size; and (6) the cooperative organization of the growers for the purpose of maintaining the seed supply, operating the gins, and marketing the crop.

Communities in which all of the above conditions can not be met are not advised to undertake the growing of Egyptian cotton. In any event, a new community which contemplates the growing of this crop should experiment at first on a small scale and under expert advice, in order to make sure before investing capital in the enterprise that the climatic and soil conditions are favorable to producing large yields and a good quality of fiber.

CONCLUSION.

The history of the establishment of Egyptian-cotton production in the Salt River Valley is believed to have more than a special or local interest, since it offers a good illustration of the numerous biological, agronomic, social, and economic difficulties encountered in developing a new agricultural industry and furnishes suggestions as to how these complex and diversified problems may be successfully solved. That cooperation is the keynote of success has become very clear in the progress of the present enterprise. In this instance cooperation has been maintained along the following lines:

(1) Cooperation among the investigators has brought to the solution of the special problems different equipments of technical training and knowledge and different points of view, while their collective judgment has been focused upon matters of general policy. The cordial and effective cooperation of the administrative officers of the Department of Agriculture has also been an important factor in this connection.

(2) Cooperation among the growers has made it possible to produce and market the crop economically and to maintain the uniformity and high quality of the variety grown.

(3) Cooperation between the growers and the investigators has made it possible to put into effect without delay the most improved methods of production and marketing. This cooperation has been maintained by personal contact, since, in addition to the field agents of the department who have worked constantly in the community,

members of the Committee on Southwestern Cotton Culture have made frequent visits to the Salt River Valley. The attitude of the officers and members of the growers' associations in their cooperation with the Department of Agriculture has been of the most cordial and helpful character, and has been a very important factor in the establishment of the industry.

(4) Cooperation with the cotton manufacturers on the part of both investigators and growers has also contributed largely to the development of the industry. Manufacturers have assisted most willingly and effectively in making spinning tests of the product from time to time, and in furnishing both to the Department of Agriculture and to the growers' associations useful information concerning the cotton. This information has guided the growers to better methods of handling the product, and has given the investigators helpful suggestions in connection with the breeding work. Some of the manufacturers interested in this type of cotton have visited the Salt River Valley in order to learn at first hand the condition and prospects of the industry, while representatives of the growers' associations and of the department have been welcome visitors at mills where the cotton is being utilized.

The policy of the Department of Agriculture in encouraging the production of long-staple cotton on the community basis is beginning to be appreciated by manufacturers and buyers, many of whom now realize that in order to obtain year after year ample quantities of cotton of unchanging character they must look to localities where the farmers are organized to grow only one kind of cotton, to prevent deterioration of the type by seed selection, and to class and market their crop as a unit.

LIST OF PUBLICATIONS BEARING ON EGYPTIAN-COTTON GROWING IN THE SOUTHWESTERN STATES.

The following is a list of publications dealing with the activities of the United States Department of Agriculture in connection with the establishment of Egyptian-cotton growing in the Southwest. Several of the publications listed do not deal directly with Egyptian cotton, but are included because they describe different phases of the investigations which have formed the basis for the establishment of this industry.

Egyptian cotton in the southwestern United States. By Thomas H. Kearney and William A. Peterson. Bureau of Plant Industry Bulletin 128. Issued June 13, 1908.

Suppressed and intensified characters in cotton hybrids. By O. F. Cook. Bureau of Plant Industry Bulletin 147. Issued April 7, 1909.

Experiments with Egyptian cotton in 1908. By Thomas H. Kearney and William A. Peterson. Bureau of Plant Industry Circular 29. Issued April 16, 1909.

A study of diversity in Egyptian cotton. By O. F. Cook, Argyle McLachlan, and R. M. Meade. Bureau of Plant Industry Bulletin 156. Issued July 24, 1909.

Local adjustment of cotton varieties. By O. F. Cook. Bureau of Plant Industry Bulletin 159. Issued September 28, 1909.

Origin of the Hindi cotton. By O. F. Cook. Bureau of Plant Industry Circular 42. Issued December 11, 1909.

Mutative reversions in cotton. By O. F. Cook. Bureau of Plant Industry Circular 53. Issued March 21, 1910.

Cotton selection on the farm by the characters of the stalks, leaves, and bolls. By O. F. Cook. Bureau of Plant Industry Circular 66. Issued August 13, 1910.

Breeding new types of Egyptian cotton. By Thomas H. Kearney. Bureau of Plant Industry Bulletin 200. Issued December 23, 1910.

Dimorphic branches in tropical crop plants: Cotton, coffee, cacao, the Central American rubber tree, and the banana. By O. F. Cook. Bureau of Plant Industry Bulletin 198. Issued January 14, 1911.

Hindi cotton in Egypt. By O. F. Cook. Bureau of Plant Industry Bulletin 210. Issued May 11, 1911.

Arrangement of parts in the cotton plant. By O. F. Cook and R. M. Meade. Bureau of Plant Industry Bulletin 222. Issued October 3, 1911.

Dimorphic leaves of cotton and allied plants in relation to heredity. By O. F. Cook. Bureau of Plant Industry Bulletin 221. Issued November 22, 1911.

Cotton improvement on a community basis. By O. F. Cook. Yearbook, U. S. Dept. of Agriculture, for 1911, pp. 397–410.

Suggestions on growing Egyptian cotton in the Southwest. By Carl S. Scofield. Bureau of Plant Industry Document 717. Issued January 9, 1912.

Results of cotton experiments in 1911. By O. F. Cook. Bureau of Plant Industry Circular 96. Issued July 17, 1912.

The branching habits of Egyptian cotton. By Argyle McLachlan. Bureau of Plant Industry Bulletin 249. Issued September 20, 1912.

Improved methods of handling and marketing cotton. By Charles J. Brand. Yearbook, U. S. Dept. of Agriculture, for 1912, pp. 443–462.

Morphology of cotton branches. By O. F. Cook. Bureau of Plant Industry Circular 109, pp. 11–16. Issued January 4, 1913.

Heredity and cotton breeding. By O. F. Cook. Bureau of Plant Industry Bulletin 256. Issued January 13, 1913.

Preparation of land for Egyptian cotton in the Salt River Valley, Arizona. By E. W. Hudson. Bureau of Plant Industry Circular 110, pp. 17–20. Issued January 18, 1913.

Fiber from different pickings of Egyptian cotton. By Thomas H. Kearney. Bureau of Plant Industry Circular 110, pp. 37–39. Issued January 18, 1913.

Egyptian cotton as affected by soil variations. By Thomas H. Kearney. Bureau of Plant Industry Circular 112, pp. 17–24. Issued February 8, 1913.

A wild host plant of the boll weevil in Arizona. By O. F. Cook. Science, n. s., v. 37, pp. 259–261. Issued February 14, 1913.

A new system of cotton culture. By O. F. Cook. Bureau of Plant Industry Circular 115, pp. 15–22. Issued March 1, 1913.

The fundamentals of crop improvement. By W. T. Swingle. Bureau of Plant Industry Circular 116, pp. 3–10. Issued March 8, 1913.

The abortion of fruiting branches in cotton. By O. F. Cook. Bureau of Plant Industry Circular 118, pp. 11–16. Issued March 22, 1913.

Leaf-cut, or tomosis, a disorder of cotton seedlings. By O. F. Cook. Bureau of Plant Industry Circular 120, pp. 29–34. Issued April 5, 1913.

Factors affecting the production of long-staple cotton. By O. F. Cook, Bureau of Plant Industry Circular 123, pp. 3–9. Issued April 26, 1913.

Egyptian cotton culture in the Southwest. By Carl S. Scofield. Bureau of Plant Industry Circular 123, pp. 21–28. Issued April 26, 1913.

Agriculture on the Yuma Reclamation Project. By Carl S. Scofield. Bureau of Plant Industry Circular 124, pp. 3–8. Issued May 3, 1913.

Cotton farming in the Southwest. By O. F. Cook. Bureau of Plant Industry Circular 132, pp. 9–18. Issued July 19, 1913.

Seed selection of Egyptian cotton. By Thomas H. Kearney. U. S. Dept. of Agriculture Bulletin 38. Issued November 19, 1913.

Cotton as a crop for the Yuma Reclamation Project. By the Committee on Southwestern Cotton Culture. Bureau of Plant Industry Document 1009. Issued December 1, 1913.

The relation of cotton buying to cotton growing. By O. F. Cook. U. S. Dept. of Agriculture Bulletin 60. Issued February 16, 1914.

Growing Egyptian cotton in the Salt River Valley, Arizona. By E. W. Hudson. U. S. Dept. of Agriculture, Farmers' Bulletin 577. Issued March 14, 1914.

Mutation in Egyptian cotton. By Thomas H. Kearney. U. S. Dept. of Agriculture, Journal of Agricultural Research, v. 2, no. 4, pp. 287–302. Issued July 15, 1914.

The wild cotton plant (*Thurberia thespesioides*) in Arizona. By Vernon Bailey. Bulletin, Torrey Botanictl Club, v. 41, pp. 301–306. Issued May 29, 1914.

Single-stalk cotton culture. By O. F. Cook. Bureau of Plant Industry Document 1130. Issued December 14, 1914.

Relation of the Arizona wild cotton weevil to cotton planting in the arid West. By B. R. Coad. U. S. Dept. of Agriculture Bulletin 233. Issued May 27, 1915.

Single-stalk cotton culture at San Antonio. By Rowland M. Meade. U. S. Dept. of Agriculture Bulletin 279. Issued August 24, 1915.

Custom ginning as a factor in cotton-seed deterioration. By D. A. Saunders and P. V. Cardon. U. S. Dept. of Agriculture Bulletin 288. Issued September 7, 1915.

The handling and marketing of the Arizona-Egyptian cotton of the Salt River Valley. By J. G. Martin. U. S. Dept. of Agriculture Bulletin 311. Issued November 26, 1915.

Community production of Durango cotton in the Imperial Valley. U. S. Dept. of Agriculture Bulletin 324.

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